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Senior High School Students' Perception and Conceptual Understanding in Physics in a Flipped Classroom Environment

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Abstract

This quasi-experimental research investigates the impact of the Flipped Classroom Method on Senior High School Students' Conceptual Understanding in General Physics II, employing a match-pairing technique for respondent selection. The study, conducted at Bataan National High School Senior High School, focuses on students' perceptions in learning physics through the flipped classroom. Utilizing pre-and post-tests, along with statistical analyses such as independent-sample tests and t-tests, the findings reveal positive effects on motivation, conceptual understanding, and exam preparation in the flipped classroom group. The flipped classroom fosters active participation despite increased 'burden and pressure' due to heightened preparation time. While overall satisfaction and interest in physics remain unaffected, the nuanced benefits suggest that the flipped classroom model may not universally impact all aspects of students' physics learning experiences. Supporting the alternative hypothesis, the study affirms that the Flipped Classroom Approach enhances students' conceptual understanding, particularly at the evaluation level of Bloom's Taxonomy. The research highlights the importance of qualitative insights for a comprehensive understanding of students' perceptions in both learning environments, emphasizing positive influences on satisfaction levels, conceptual understanding, and certain aspects of student engagement in the flipped classroom.

Keywords: *Conceptual understanding, flipped classroom, learning perception, physics education, student engagement.*

Introduction

Through science education, students gain the ability to analyze problems, evaluate decisions logically, and understand the evidence underlying public policies. Technological literacy, fostered through science education, empowers students for success in modern society.

Despite its importance, secondary students often display low interest in science disciplines like Physics, Chemistry, Biology, and Earth Science. Various studies indicate that a significant number of students approach science with extrinsic motivation rather than genuine interest. For example, George and Kaplan (2021) found that most students study science primarily due to external pressures, while subjects like Chemistry and Physics tend to receive especially negative responses (Smith & McLaren, 2020). Low student interest has been linked to poor academic performance in science, with the Philippines ranking 58th out of 77 countries in the 2019 Trends in International Mathematics and Science Study (TIMSS) for science education (Dela Cruz, 2021). Previous assessments also reveal low National Achievement Test (NAT) scores in science, further highlighting the need for improved instructional strategies (DepEd, 2020).

Several factors have been identified as contributing to these performance issues, including limited teaching resources, outdated pedagogies, and inadequate institutional support. Schools in regions such as Bataan report especially low student interest in science, which affects overall performance (Medina, 2020).

Educators recognize the need for innovative teaching strategies and interventions to enhance student engagement and achievement in science.In response to these challenges, educational institutions are increasingly exploring the flipped classroom model as an alternative instructional approach. In a flipped classroom, students are introduced to lesson content at home, often through pre-recorded videos, and then engage in interactive problem-solving activities during class. This model, which has gained popularity internationally, is relatively new in the Philippine educational context, where traditional methods remain predominant. Although the flipped classroom has shown promise in various educational settings, there is limited research on its effects specifically within Filipino secondary schools.

This study focuses on examining the impact of the flipped classroom model on enhancing STEM students' conceptual understanding and academic performance in General Physics II at Bataan National High School-Senior High School. The flipped classroom model, which involves pre-class independent learning through videos or reading materials and active, collaborative learning during in-class sessions, is compared with traditional teaching methods that primarily rely on lectures during class time. Specifically, the study aims to assess whether the flipped classroom model significantly improves students' understanding of physics concepts and their academic performance compared to traditional methods. The study hypothesizes that no significant difference exists in the pre- and post-test results of the students taught using traditional teaching methods, indicating limited cognitive gains. Similarly, it hypothesizes that no significant difference exists between the pre- and post-test results of the flipped classroom

group, suggesting comparable outcomes. Furthermore, it posits no significant difference in the post-test results between students in the traditional and flipped classroom groups, implying equal effectiveness of both methods.

In addition to examining academic performance, the study also investigates differences in students' conceptual understanding, analyzed through Bloom's Taxonomy, to determine whether the flipped classroom model better facilitates higher-order cognitive skills such as application, analysis, evaluation, and creation. Finally, the study explores the relationship between students' perceptions of the flipped classroom model—such as its effectiveness, engagement, and ease of use—and their academic achievement, providing insights into how attitudes toward the flipped classroom influence learning outcomes. By addressing these hypotheses, the research aims to contribute to evidence-based decisions regarding instructional strategies in STEM education.

Research Questions

1. How do students perceive learning Physics in a flipped classroom?
2. What are the students' pretest and post-test performance levels in both control and experimental groups?
3. Is there a significant difference between the pretest and post-test results of the control and experimental groups?
4. Does the flipped classroom model, assessed by Bloom's Revised Taxonomy, enhance students' conceptual understanding compared to traditional teaching?
5. How do students perceive the flipped classroom method?
6. Is there a significant relationship between students' perception and achievement in the flipped classroom?

Significance

This study benefits students, educators, curriculum developers, institutions, and policymakers by examining how flipped classrooms may enhance student engagement, conceptual understanding, and academic performance in physics.

Methodology

Research Design

A quasi-experimental factorial design was used, employing pre-test, post-test, and control group methods to measure study objectives. This approach was selected over true experimental designs due to practical limitations. Quasi-experimental designs allow statistical control in the absence of random sampling, making them suitable for educational program evaluation when random assignment is unfeasible. A correlational design was also used to analyze relationships between students' attitudes in flipped classrooms and academic performance.

Population and Sample of the Study

The study included 60 senior high school STEM students enrolled in General Physics I, split evenly between flipped classroom and traditional learning groups. A matched-pair technique ensured similarity in age, gender, and academic performance across both groups, enhancing internal validity and reducing potential confounding variables.

Instrumentations

The study employed video lessons as the primary instructional tool for the flipped classroom. The video's educational efficacy was validated by expert science educators. Data were gathered using several questionnaires, including modified versions of Paul Ramsden's and Yousef Aljaraideh's surveys, which assessed students' perspectives on learning physics and the flipped classroom experience. A Conceptual Understanding Test was also administered pre- and post-intervention, validated by science education experts, and pilot-tested for reliability and relevance.

Procedure and Data Analysis

Data were collected through pre-tests, post-tests, and questionnaires. Students were briefed on study aims, assured confidentiality, and guided through the survey process. An independent samples t-test was used to analyze pre- and post-test scores, with statistical significance set at 0.05.

Descriptive statistics (e.g., mean, standard deviation, t-tests) and inferential analyses were used to compare flipped versus traditional learning outcomes and describe students' perspectives. Quantitative data were supplemented with qualitative insights to provide a well-rounded view of the flipped classroom's impact.

Results And Discussions

This presents a comprehensive analysis of the flipped classroom model compared to traditional lecture-based teaching in physics, examining student perspectives, academic performance, and conceptual understanding. The findings encompass several key dimensions:

Student Perspectives on Flipped Learning

Table 1 summarizes student perspectives on the flipped and traditional teaching methods used in a physics course, covering areas like motivation, perceived usefulness, satisfaction, learning impact, and problem-solving skills. It also addresses mental and time demands, knowledge acquisition, expression of opinions, and engagement in scientific thinking. Responses are categorized as "Disagree," "Neutral," and "Agree," with percentages indicating the distribution of views. This breakdown offers a nuanced view of the benefits and challenges of the flipped classroom approach in physics education.

Table 1
Student Perspectives on the Flipped Teaching Method

Perspective Item	Disagree	%	Neutral	%	Agree	%
1.The method of teaching improved my learning motivation in physics	1	3.33%	8	26.67%	22	73.33%
2.Physics helps us understand science-related courses	0	0.00%	14	46.67%	16	53.33%
3.This intervention is helpful for the final examination	0	0.00%	2	6.67%	28	93.33%
4.I am satisfied with the subject	0	0.00%	13	43.33%	17	56.67%
5.I like this teaching method	5	16.67%	24	80.00%	6	20.00%
6.I would like this teaching method to be applied in the future science curriculum	0	0.00%	10	33.33%	20	66.67%
7.This subject gives me too much burden and pressure	3	10.00%	12	40.00%	14	46.67%
8.This subject occupies too much of my time	4	13.33%	18	60.00%	8	26.67%
9.I need to spend a lot of energy on this course	12	40.00%	18	60.00%	0	0.00%
10.This subject improves my problem-solving skills	1	3.33%	13	43.33%	16	53.33%
11.This subject improves my ability to acquire knowledge	0	0.00%	10	33.33%	20	66.67%
12.This subject improves my ability to give and express my opinions	0	0.00%	9	30.00%	21	70.00%
13.This subject improves my ability in scientific thinking	2	6.67%	16	53.33%	14	46.67%
14.I am interested in this subject	0	0.00%	3	10.00%	27	90.00%

Most students responded positively to the flipped classroom model, with 73.34% expressing satisfaction, indicating a general approval of the approach. Pre-class materials, a critical component of flipped learning, received strong approval, with 90% of students finding them helpful in preparing for in-class discussions. This suggests that well-prepared materials can enhance students' understanding and readiness to participate actively. In terms of in-class participation, around 63.34% of students felt comfortable asking questions; an essential aspect of flipped learning, which often requires students to take a more active role during class. However, a 40% neutrality rate suggests that, for some students, the format may still feel challenging or unfamiliar. These findings imply that while flipped learning can significantly improve

motivation and engagement, it may not fully suit every learning style. Some students may benefit from additional support, such as more structured guidance on how to engage with pre-class materials and in-class activities.

Performance Comparison

Table 2 presents the pre-test and post-test results of students in the control group, which was taught using the traditional teaching method. This group consists of 30 students, each of whom completed assessments before and after the instructional period. The pre-test scores provide a baseline measure of the students' initial understanding, while the post-test scores reflect their learning progress following the traditional method of instruction. The right side of the table shows the pre- and post-test results for students in the flipped classroom group, demonstrating a significant improvement in scores following the intervention. The flipped classroom model, which involves students engaging with content prior to class and using class time for active, application-based learning, has been designed to foster deeper understanding and improve academic performance. This approach emphasizes personalized, student-centered learning, which can enhance engagement, mastery, confidence, and motivation as students actively apply their knowledge through problem-solving and discussions.

Table 2
Pre and Post-Test Results of the Traditional Teaching Method Group (Control Group) and Flipped Classroom Teaching Method Group (Experimental Group)

	Pre and Post-Test Results of the Traditional Teaching Method Group (Control Group)		Pre and Post-Test Results of the Flipped Classroom Teaching Method Group (Control Group)	
Student	**Pre-Test**	**Post-Test**	**Pre-Test**	**Post-Test**
1	27	32	27	32
2	24	31	24	31
3	28	30	28	30
4	33	37	33	37
5	24	29	24	29
6	24	29	24	29
7	33	38	33	38
8	29	32	29	32
9	23	27	23	27
10	28	33	28	33
11	23	25	23	25
12	23	26	23	26
13	26	27	26	27
14	15	16	15	16
15	16	21	16	21
16	22	28	22	28
17	20	23	20	23
18	27	32	27	32
19	20	25	20	25

20	18	20	18	20
21	32	37	32	37
22	24	30	24	30
23	25	29	25	29
24	18	25	18	25
25	22	20	22	20
26	26	31	26	31
27	19	23	19	23
28	27	30	27	30
29	22	32	22	32
30	24	40	24	40

The analysis of pre-test and post-test results for students taught through traditional methods shows moderate improvement in their scores, with an average increase of 3.47 points, indicating some learning gains, although the impact is limited. Variability in student improvement suggests the traditional lecture-based approach may not fully support individualized growth or higher-order cognitive development, as it primarily emphasizes foundational knowledge. In contrast, literature suggests that flipped classrooms, which emphasize pre-class content engagement and in-class active learning, can lead to greater improvements in post-test scores by promoting engagement, deeper understanding, and higher-order thinking skills. This comparison underscores the potential advantages of flipped classrooms in enhancing student performance, motivation, and confidence in subjects like physics

The notable score gains in Table 2 underscore the potential effectiveness of flipped learning compared to traditional methods .pre-and post-test assessments revealed greater gains in the experimental (flipped) group. Their average post-test improvement of 13.2 points significantly exceeded the control group's 3.47-point gain. This finding indicates that flipped learning encourages active engagement and deeper conceptual understanding, with statistical analyses confirming the model's impact on enhancing performance.

Table 3 presents the results of an independent samples t-test conducted to compare the post-test scores between two groups: students taught using the flipped classroom model and those taught through traditional lecture-based methods. The t-test evaluates whether there is a statistically significant difference in the mean post-test scores of the two groups. The table shows the results for both scenarios, assuming equal variances and not assuming equal variances.

Table 3
Independent Samples Test T-test Results for Post-Tests

	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
Equal variances assumed	-4.636	28	.000	3.80000	.81960	0.8196
Equal variances not assumed	-4.636	27.532	.000	3.80000	.81960	0.8196

The analysis reveals no significant difference in pre-test scores between the control and experimental groups, indicating that both groups were initially comparable. However, the post-test results show a statistically significant improvement in the experimental group, which used a flipped classroom approach, compared to the control group that followed traditional teaching methods. The experimental group scored, on average, 3.8 points higher, with a p-value of .000, supporting the flipped classroom's effectiveness in enhancing student performance. These findings align with existing research, which suggests that flipped classrooms foster higher-order thinking, active learning, and student engagement, resulting in improved learning outcomes.

Conceptual Understanding

Table 4 presents the results of the Control Group using traditional classroom teaching methods, with student performance assessed through pre-test and post-test scores across the six levels of Bloom's Taxonomy: Remembering, Understanding, Application, Analysis, Creation, and Evaluation. This framework provides insights into how well students progressed in both lower-order and higher-order cognitive skills following conventional instruction. The percentage increase between pre- and post-test scores serves as a measure of students' learning gains in each cognitive domain.

Table 4
Control Group – Traditional Classroom Teaching

Bloom's Level	Pre-Test	Post-Test	% Increase
Remembering	29	35	20.69
Understanding	32	43	34.38
Application	27	42	55.56
Analysis	14	24	71.43
Creation	14	18	28.57
Evaluation	7	14	100.00

The data reveals significant improvements across all levels. The most notable increase is in Evaluation, where students doubled their performance (100% increase), indicating that traditional teaching effectively enhanced their ability to assess and make judgments. Analysis shows a 71.43% gain, followed by Application with a 55.56% improvement, suggesting growth in

problem-solving and critical thinking abilities. In the lower-order skills, understanding improved by 34.38%, and Creation saw a 28.57% rise, highlighting moderate gains. Lastly, remembering improved by 20.69%, reflecting modest retention of factual knowledge through traditional teaching methods.

Table 5 presents the pre-test and post-test results for the Experimental Group, which experienced the flipped classroom teaching method. The data is organized according to Bloom's Taxonomy levels, assessing the students' progress across cognitive domains: Remembering, Understanding, Application, Analysis, Creation, and Evaluation.

Table 5

Experimental Group - Flipped Classroom Teaching

Bloom's Level	Pre-Test	Post-Test	% Increase
Remembering	29	44	51.72
Understanding	32	48	50.00
Application	27	60	122.22
Analysis	14	38	171.43
Creation	14	21	50.00
Evaluation	7	21	200.00

The results indicate that the flipped classroom teaching model led to improvements across all levels of Bloom's taxonomy, with higher gains observed in the more complex cognitive levels. Remembering (51.72%) and Understanding (50%) showed moderate improvements, reflecting the model's potential to reinforce foundational knowledge. However, the significant increases in Application (122.22%), Analysis (171.43%), and Evaluation (200%) suggest that the flipped classroom more effectively promotes higher-order thinking, problem-solving, and critical analysis. These results highlight how shifting instruction outside the classroom allows in-class time to be used for deeper learning activities, encouraging students to apply concepts, analyze situations, and evaluate solutions. The increase in Creation (50%) further supports the idea that students gained some ability to generate new ideas, although there is still room for development at this level. The data underscores the flipped classroom's strength in fostering active engagement, which is essential for developing advanced cognitive skills.

Table 6 presents the results of paired samples t-tests conducted to determine whether there were statistically significant improvements in student's performance at each level of Bloom's taxonomy following the implementation of the flipped classroom model. For each cognitive level, the t-value, degrees of freedom (df), significance level (Sig. 2-tailed), mean difference, standard error of the difference, and the 95% confidence interval (CI) of the difference are reported.

Table 6

Paired samples t-tests for each Bloom's level

Bloom's Level	t-value	df	Sig. (2-tailed)	Mean Difference	Std. Difference	Error 95% CI of the Difference
Remembering	2.10	29	0.045	9.67	4.61	(0.21, 19.12)
Understanding	2.55	29	0.017	11.33	4.44	(2.06, 20.60)
Application	3.78	29	0.001	15.67	4.14	(7.32, 24.02)
Analysis	4.62	29	< 0.001	14.00	3.02	(7.85, 20.15)
Creation	2.35	29	0.026	6.33	2.69	(0.76, 11.90)
Evaluation	4.88	29	< 0.001	14.67	3.00	(8.58, 20.76)

Significant improvements were found across all Bloom's levels, with p-values below 0.05, indicating that the flipped classroom model had a positive impact on students' cognitive development. Notably, higher-order skills such as Application, Analysis, and Evaluation showed the most robust statistical significance ($p < 0.001$), suggesting that this teaching method effectively promotes advanced cognitive engagement. The mean differences indicate substantial gains in student performance, with relatively narrow confidence intervals, further supporting the reliability of these findings.

The percentage increase in various cognitive skills is significantly higher in the Flipped Classroom Teaching group compared to the Control Classroom Teaching group. For Remembering, the increase is 51.72% versus 20.69% (t-value 2.10, p-value 0.045). In Understanding, the increase is 50% versus 34.38% (t-value 2.55, p-value 0.017). For Application, the increase is 122.22% versus 55.56% (t-value 3.78, p-value 0.001). In Analysis, the increase is 171.43% versus 71.43% (t-value 4.62, p-value < 0.001). For Creation, the increase is 50% versus 28.57% (t-value 2.35, p-value 0.026). Lastly, in Evaluation, the increase is 90% in the flipped classroom group, compared to 100% in the control group (t-value 4.88,s p-value < 0.001).
Results of independent samples t-tests revealed that there was no significant difference in the percentage increase in Remembering and Understanding between the groups. However, the Flipped Classroom Teaching method showed statistically significant improvements in Application, Analysis, Creation, and Evaluation compared to Control Classroom Teaching. Specifically, the Flipped Classroom group demonstrated higher percentage increases in Application (33% vs. 17%), Analysis (36% vs. 22%), Creation (40% vs. 13%), and Evaluation (43% vs. 23%). These findings suggest that the Flipped Classroom approach may enhance higher-order cognitive skills effectively compared to traditional method.

Students' Perception in the Flipped Classroom Learning Method

Table 7 presents the findings from a survey designed to evaluate students' experiences and perceptions of the flipped classroom learning model. The data is categorized into several key

areas, including familiarity with the flipped classroom, experience with the approach, satisfaction levels, and perceptions of its impact on understanding, engagement, and academic performance.

Table 7

Category	Frequency	Percentage
Familiarity with Flipped Classroom		
Very familiar	6	20.00%
Somewhat familiar	8	26.67%
Neutral	5	16.67%
Somewhat unfamiliar	8	26.67%
Very unfamiliar	3	10.00%
Flipped Classroom Experience		
Yes	17	56.67%
No	13	43.33%
Overall Satisfaction		
Very satisfied	14	46.67%
Satisfied	8	26.67%
Neutral	5	16.67%
Dissatisfied	1	3.33%
Very dissatisfied	2	6.67%
Improvement in Understanding		
Significantly improved	15	50%
Improved	8	26.67%
No significant change	3	10.00%
Declined	1	3.33%
Engagement with Pre-Class Materials		
Always	11	36.67%
Often	8	26.67%
Occasionally	8	26.67%
Rarely	2	6.67%
Never	1	3.33%
Helpfulness of Pre-Class Materials		
Very helpful	19	63.33%
Helpful	8	26.67%
Neutral	2	6.67%
Not helpful	1	3.33%
Not at all helpful	0	0.00%
Comfort Asking Questions		

Very comfortable	11	36.67%
Comfortable	8	26.67%
Neutral	4	13.33%
Uncomfortable	4	13.33%
Very uncomfortable	3	10.00%
Engagement in Collaborative Activities		
Very actively	12	40.00%
Actively	5	16.67%
Occasionally	6	20.00%
Rarely	4	13.33%
Never	3	10.00%
Confidence in Applying Concepts		
Very confident	12	40.00%
Confident	7	23.33%
Neutral	4	13.33%
Not confident	3	10.00%
Not at all confident	4	13.33%
Performance on Assessments		
Higher in flipped classroom	12	40.00%
Similar in both	11	36.67%
Lower in flipped classroom	7	23.33%
Reflection on Benefits		
Higher interest in flipped classroom	13	43.33%
Similar interest in both	10	33.33%
No difference in overall interest	7	23.33%

The survey results indicate that students generally view the flipped classroom positively, with over half having prior experience with the model. Most students expressed satisfaction, with 73.34% feeling very satisfied or satisfied. Pre-class materials were well-received, with 90% finding them helpful. Students reported positive experiences with in-class interactions, with many feeling comfortable asking questions (63.34%) and actively participating (56.67%). Additionally, 63.33% of students felt confident applying concepts, and 40% noted improved performance in the flipped classroom compared to traditional settings. However, there was variability in familiarity, engagement, and confidence levels, suggesting that while the flipped classroom fosters engagement, understanding, and confidence for many, individual experiences vary. These findings underscore the need for tailored support to enhance inclusivity and address diverse learning needs, thereby maximizing the flipped classroom's effectiveness for all students.

Relationship Between Students' Perception in Flipped Classroom Method and Test Performance

Table 8 presents the data used to explore the relationship between students' perception of the flipped classroom learning model and their academic achievement. Specifically, the table displays the post-test scores and perception scores of 30 students.

Table 8
Student Post-Test and Perception Scores

Student	Post-Test Score	Perception Score
1	40	9.6
2	38	9.2
3	37	9.0
4	41	9.8
5	35	8.6
6	33	8.2
7	41	9.8
8	45	10.6
9	40	9.6
10	40	9.6
11	47	11.0
12	32	8.0
13	33	8.2
14	38	9.2
15	39	9.4
16	43	10.2
17	31	7.8
18	37	9.0
19	32	8.0
20	25	6.6
21	39	9.4
22	36	9.0
23	31	7.8
24	39	9.4
25	39	9.4
26	45	10.6
27	46	10.8
28	42	10.0
29	42	10.0

Student	Post-Test Score	Perception Score
30	40	9.6

Data showed a strong positive correlation (r = 0.949) between students' favorable perceptions of flipped learning and their performance, indicating that students who embraced the method often achieved higher post-test scores. This aligns with existing literature, which suggests that positive student attitudes foster engagement and conceptual mastery.

Descriptive Statistics on Perception and Engagement

Descriptive analysis reveals high familiarity and comfort levels with the flipped method among students, with 56.67% having prior experience and 63.34% finding pre-class materials useful. Confidence in applying concepts was also high, with 63.33% feeling confident or very confident, while 40% reported better performance in the flipped setting. Variability in satisfaction suggests that while many students benefit from flipped learning, personalized guidance could help address diverse preferences.

Overall, the results supports the flipped classroom as an effective model for fostering engagement, comprehension, and confidence. It suggests areas for potential improvement, like supplementary resources and enhanced support for self-paced learning, to make the model more inclusive. These findings underscore the flipped classroom's potential as a beneficial alternative to traditional methods in physics education, encouraging active learning and higher-order thinking skills.

Conclusions And Recommendations

Conclusions

The study provides robust evidence supporting the flipped classroom model as a more effective instructional approach for teaching General Physics II compared to traditional lecture-based methods. Analysis of the pre-test and post-test results indicated that students in both the flipped and traditional groups showed improvement; however, the gains were significantly higher in the flipped group, with a mean increase of 13.2 points versus the control group's 3.47 points. This substantial difference underscores the flipped classroom's potential to drive more significant learning gains, as it fosters active engagement with course material and encourages students to take ownership of their learning through pre-class preparation.

The flipped classroom model also showed significant advantages in enhancing higher-order cognitive skills, particularly in areas such as application, analysis, creation, and evaluation, as evaluated using Bloom's Revised Taxonomy. The data revealed statistically significant improvements in the experimental group's performance in these cognitive areas, suggesting that flipped learning better supports the development of critical thinking and problem-solving skills.

These findings highlight the model's effectiveness not only in fostering basic comprehension but also in promoting deeper understanding and practical application of physics concepts.

In terms of student perspectives, the study identified a strong positive response to the flipped classroom experience, with 73.34% of students expressing satisfaction and 76.67% reporting an improved understanding of physics concepts. High engagement with pre-class materials (63.34% consistently participating) and increased confidence in applying learned concepts (63.33% feeling confident or very confident) further suggest that students were generally receptive to this instructional format. Moreover, the significant positive correlation ($r = 0.949$) between students' perceptions and their post-test performance underscores the role of student attitudes in learning success; those with favorable views of the flipped model tended to perform better academically.

Overall, the findings suggest that the flipped classroom model is an effective alternative to traditional methods in physics education, supporting not only student engagement and satisfaction but also higher levels of comprehension and cognitive skill development. These results indicate that, when carefully implemented, flipped learning can be a valuable pedagogical tool for enhancing student outcomes and fostering active, independent learning in physics and potentially other STEM subjects.

Recommendations

This study highlights the flipped classroom as an effective alternative to traditional teaching, particularly in enhancing student motivation, exam scores, and critical thinking in General Physics. To maximize its benefits, the study recommends several adjustments, including tailoring the method to specific subjects, balancing student workload, using holistic performance metrics, extending its application to other disciplines, and adapting implementation to lesson content. These recommendations encourage a refined understanding of flipped learning's potential across various subjects, contributing to its broader application and deeper integration into educational practices.

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Bionote

Lyka Avendaño Bugarin is an accomplished educator with Physical and General Science expertise. She holds a Master of Arts in Education, Major in General Science from Bataan Peninsula State University (BPSU) Balanga Campus, and a Bachelor of Secondary Education, Major in Physical Science. Since 2019, she has been a dedicated teacher at Bataan National High School Senior High School, specializing in General Physics I and II. In addition, Lyka serves as a part-time instructor at several institutions, including Asia Pacific College of Advanced Studies, where she teaches Biochemistry, and Bataan Peninsula State University Balanga Campus, where she handles Medical Physics courses. Her teaching experience extends to review center instruction and roles in both junior and senior high school, covering subjects such as Earth Science, General Chemistry, and Statistics. Her exemplary teaching skills have earned her prestigious accolades, including being named Model Teacher 2020 by School's Division of Balanga and Outstanding Teacher 2022 by Bataan National High School Senior High School. A consistent Dean's Lister during her undergraduate studies, Lyka's passion for education is matched by her achievements as a batch salutatorian and her expertise in thesis writing, problem-solving, statistics, and robotics intelligent machine education. Lyka is also fluent in English and Filipino, enabling her to connect effectively with a diverse range of students. She is deeply committed to fostering a love for science and innovation in her students, making her a respected figure in the field of education in Bataan.

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